DOCUMENT RESUME

ED 209 083 SE 035 789

AUTHOR Schunk, Dale H.
TITLE Development of Children's Achievement and Interest Through Overt Verbalization.
PUB DATE Aug 81
NOTE 20p.; Paper presented at the Annual Meeting of the American Psychological Association (Los Angeles, CA, August, 1981). Not available in paper copy due to light and broken type throughout entire document.

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Academic Achievement; Arithmetic; Basic Skills; Cognitive Development; *Computation; *Division; Elementary Education; *Elementary School Mathematics; Evaluation; *Learning Theories; *Mathematics Achievement; Mathematics Instruction; Student Attitudes; Testing; *Verbal Communication
IDENTIFIERS *Mathematics Education Research

ABSTRACT

This experiment tested the hypothesis that combining operational strategies with free verbalization facilitates development of competencies, percepts of self-efficacy, and interest in arithmetic activities. Children lacking division skills received treatments in which they either verbalized division strategies, verbalized freely, did both, or did not verbalize while learning to solve division problems. Results showed that combining operational strategies with free verbalization produced greater skill development, higher percepts of efficacy, and greater subsequent interest. Free verbalization alone led to equally high skill development. Verbalizing only strategies resulted in no benefits compared with not verbalizing. Regardless of treatment condition, self-percepts of efficacy were positively related to arithmetic interest. (Author)

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Development of Children's Achievement and Interest Through Overt Verbalization

Dale H. Schunk

University of Houston

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Abstract

This experiment tested the hypothesis that combining operational strategies with free verbalization facilitates development of competencies, percepts of self-efficacy, and interest in arithmetic activities. Children lacking division skills received treatments in which they either verbalized division strategies, verbalized freely, did both, or did not verbalize while learning to solve division problems. Results showed that combining operational strategies with free verbalization produced greater skill development, higher percepts of efficacy, and greater subsequent interest. Free verbalization alone led to equally high skill development. Verbalizing only strategies resulted in no benefits compared with not verbalizing. Regardless of treatment condition, self-percepts of efficacy were positively related to arithmetic interest.

Development of Children's Achievement and Interest Through Overt Verbalization

Influential work in speech development (Luria, 1959; Vygotsky, 1956) indicates a stage progression of increasing verbal self-control of behavior, beginning with external guidance, progressing to overt self-guidance, and culmination in covert verbal self-control. Although this evidence suggests that self-verbalization can facilitate the acquisition of skills, research has not clearly supported this idea. Some studies have found that performance is improved when children verbalize aloud material to be remembered or instructional strategies to be followed (Levin, Ghatala, Wilder, & Inzer, 1973; Meichenbaum & Goodman, 1971; Taylor, Josberger, & Whitely, 1973; Whitely & Taylor, 1973). Other investigators have failed to find any benefits of self-verbalization on children's skillful performance compared with training procedures that do not involve verbalization (Denney, 1975; Denney & Turner, 1979), nor do treatments preventing self-verbalization lead to gross performance decrements (Kemp & Perry, 1979).

One factor that may help explain this inconsistency concerns the type of verbalization that children engage in. For example, children can repeat specific statements such as the exact words of the experimenter. Such verbalizations should promote performance in that they have attentional effects (Levin, Ghatala, DeRose, Wilder, & Norton, 1975). While some research (Coates & Hartup, 1969) has found them to be effective, other (Denney, 1975) has not. It has been suggested that structured repetition may promote performance more on tasks requiring memory than on those demanding more integrative or constructive cognitive activity (Ghatala, Levin, Davis, & Truman, in press).

Conversely, children can construct their own verbalizations. As before, the effectiveness of self-generated verbalizations has been demonstrated in some studies (Asarnow & Meichenbaum, 1979; Meichenbaum & Goodman, 1971; Taylor, et al., 1973; Whitely & Taylor, 1973), but not in others (Coates & Hartup, 1969). One possibility is that free verbalizations are most effective when they focus attention on the problem-solving process and help tie strategies to specific problems. Effectiveness is limited when they are overly difficult to generate or interfere with attentional processes.

One purpose of the present study was to compare the effects of strategy verbalization, alone and in combination with those of free verbalization, in the acquisition of cognitive competencies. A second purpose was to extend the research on self-verbalization to the development of self-efficacy. According to Bandura (1977, 1981), influences change behavior partly by creating and strengthening percepts of self-efficacy. Self-efficacy is concerned with judgments of one's capability to perform given activities. As persons develop higher and stronger self-percepts of efficacy, they are more apt to engage in the activity, persist in the face of difficulty, and demonstrate greater achievement.

In developing self-efficacy, understanding the nature of task demands provides a standard against which to compare and judge the adequacy of performance. As children gain mastery, they perceive themselves as increasingly more efficacious problem solvers. By focusing attention on the strategies and processes of problem solving, verbalization should aid understanding of task demands and personal capabilities. On the assumption that combined self-verbalization helps children match appropriate strategies to task demands, it was expected to enhance the development of competencies and perceived self-efficacy.

A third purpose of this study was to examine how self-efficacy is related to task interest. Interest research has tended to focus on the effects of extrinsic rewards on high initial interest (Karniol & Ross, 1977; Lepper & Greene, 1978; Rosenfield, Folger, & Adelman, 1980; Ross, 1976). However, little research has been conducted on the conditions under which interest develops when it is low to begin with.

Both self-efficacy theory (Bandura, 1981) and the theory of intrinsic motivation (Deci, 1975) posit perceived competence as a mediating factor in the development of interest. In support of this hypothesis, Bandura and Schunk (in press) found that perceived self-efficacy fostered through self-directed study was positively related to subsequent intrinsic interest in the activity.

Perceived efficacy was expected to be associated with high interest across all treatment conditions. However, to the extent that children perceive themselves as more efficacious as a result of skill acquisition through verbalizing self-guidance along with strategies, they should exhibit increased subsequent interest in the task.

Method

Subjects

The subjects were 44 children ($\underline{M}$ = 10 years, 7 months) of predominantly middle-class backgrounds. The 21 males and 23 females were drawn from nine public school elementary classes. Teachers initially identified children who lacked skills in arithmetic division. These children were then individually administered the pretreatment assessment by an adult tester.

Pretreatment Assessment

Interest test. The interest test was administered during the first session. Children were provided with two stacks of papers each consisting of eight pages. One stack contained four rows of digit-symbol problems per page adapted from the Wechsler Intelligence Scale for Children (Wechsler, 1974). The other stack contained three division problems per page of varying difficulty. Children were informed that they could work on digit-symbol problems, or division problems, or on both; the choice was theirs. Children worked on this task alone and out of sight of the tester for 30 minutes. The measure of interest was the number of division problems children worked on.

Self-efficacy judgment. Children's percepts of self-efficacy for solving division problems were measured on the day after the interest test following procedures developed earlier (Bandura & Schunk, in press; Schunk, 1981). The efficacy scale ranged from 10 to 100 in 10-unit intervals from high uncertainty, through intermediate values of uncertainty, to complete certitude, where the higher the scale value, the stronger was the perceived efficacy. Initially, children were given practice with the efficacy assessment. Following this practice, children were shown 14 sample pairs of division problems for about 2 seconds each. This procedure allowed children to assess problem difficulty but the time was too brief to attempt to solve the problems. The two problems constituting each pair were similar in form and operations required. For each pair, children privately judged their certainty of being able to solve the type of problem depicted by circling an efficacy value.

Each pair of problems corresponded in form and operations required to one problem on the subsequent skill test but they were not the same problems. Children were judging their capability to solve types of problems and not whether they could solve any particular problem. The measure of self-efficacy was the number of judgments children recorded in the upper half (above 50) of the efficacy scale.

Division skill test. Immediately following the efficacy assessment, children received the skill test, which consisted of 14 division problems graded in difficulty and ranging from 1-3 digits in the divisor and 2-5 digits in the dividend. Of these 14 problems, 7 were similar in form and required operations to the types children solved during the training sessions. The remaining 7 problems were more complex and were included as measures of generalization. For example, during training children had to "bring down" numbers only once or twice, whereas a generalization problem required children to bring down three numbers. The measure of skill was the number of problems in which children correctly applied division operations. Problems with small computational errors--as in subtraction--were scored as correct.

The tester presented the problems to children one at a time with instructions to turn the page over after they finished the problem or chose not to work on it any longer. The tester recorded the time children spent with each problem. These persistence times were summed across problems and averaged.

Training Procedures

Since this study focused on processes by which competencies can be developed when they are initially lacking, children who correctly solved more than four problems on the skill test were excluded from the study. Children were randomly assigned within sex to one of the following four conditions of 11 subjects each: strategy verbalization, free verbalization, strategy-plus-free (combined) verbalization, no verbalization.

On consecutive school days, children received two, 45-minute training sessions, during which they worked on two sets of instructional material. Each set followed a similar format except that the first set covered one-digit divisors while the second set covered two-digit divisors. The first page of each set explained how to work the problems in the set. This page contained one step-by-step worked example that involved bringing down one number. Next to each step appeared a brief written strategy descriptor: check, multiply, check, copy, subtract, check, bring down. Since the problem presented on the explanatory page required that one number be brought down, the entire sequence of seven verbal descriptors appeared twice on the page. The second page in each set contained a practice problem. The next 15 pages contained two problems per page for children to solve.

For each session, children were brought individually to the room by an adult proctor at staggered times and were seated at desks that faced away from one another to preclude visual contact between children. The desks were sufficiently separated so that children could not overhear the verbalizations of others.

Initially, the proctor reviewed orally the explanatory page with each child individually. The proctor read from a separate narrative while pointing with a pencil to the relevant operations. As part of this narrative, the proctor verbalized the verbal descriptors at the appropriate points. Following this explanation, the proctor gave the verbalization instructions depending on the child's experimental condition. To insure that children understood these instructions, children solved the practice problem in the proctor's presence and verbalized as instructed. The proctor then retired to a location that was out of sight of all children. At the end of each session, the

proctor checked, through a series of questions, to insure that children in the verbalization conditions used the verbal procedures suggested to them.

Treatment Conditions

Strategy verbalization. Children assigned to this condition were told to verbalize aloud each of the strategy descriptors just before actually applying it to the problem they were solving. In this and the other verbalization conditions, the proctor reiterated the appropriate instructions prior to the second session.

Free verbalization. The children in this condition were instructed to say aloud whatever they were thinking while solving the problems. The explanatory page provided to these children was identical to that given to strategy verbalization children except that the strategy descriptor words were omitted. This was done to insure that these children would not simply verbalize the descriptors and thus merge into the strategy condition.

Strategy-plus-free (combined) verbalization. These children were instructed to both verbalize aloud the strategy descriptors and to express their spontaneous thoughts while solving the problems. Since these children were asked to verbalize the strategies, their explanatory pages contained the descriptor words.

No verbalization. These children received the same instructional material as children in the other conditions but were given no verbalization instructions. Their explanatory pages contained the descriptor words to control for the effects of providing the words included in the two strategy conditions.

Posttreatment Assessment

The posttest was administered individually by a tester 1-2 days following the second training session. The procedures were similar to the pretest except that a parallel form of the skill test was used and self-efficacy was assessed

before and after the skill test. The self-efficacy assessment prior to the skill test yields a measure of treatment effects; these scores can also be used to determine how well efficacy judgment predicts subsequent performance. The efficacy assessment after the skill test shows whether perceived efficacy is affected by test performance; these scores can also be related to subsequent interest. The interest test was readministered within a week of the posttest; this delay minimized potential satiation effects due to extensive exposure to division during testing and training.

Results

Preliminary analyses showed that there were no significant differences due to tester or sex of the child on any pre- or post-treatment measure; the data were therefore pooled across these variables. There also were no significant differences between treatment conditions on any pretest measure.

Pre- and post-treatment means and standards deviations are shown by experimental condition in Table 1. Within each condition, intrasubject changes on each measure were evaluated using the *t* test for correlated scores (Winer, 1971). These values are shown in Table 2. Analysis of variance procedures were applied to the posttreatment measures with the four experimental groups constituting the treatment factor. Significant *F* ratios were further analyzed using the Newman-Keuls multiple comparison test (Kirk, 1968).

Insert Tables 1 and 2 about here

Skill

All experimental conditions showed significant improvements in division skill, as is depicted in Table 2. Analysis of variance of the posttest scores yielded a significant treatment effect, $F(3, 40) = 6.89$, $p < .001$. Newman-Keuls comparisons showed that although the free and combined verbalization conditions did not differ from each other, they both produced greater skill improvement than did strategy verbalization ($p < .01$) or no verbalization ($p < .05$). The latter two conditions did not differ from one another.

Persistence

Table 2 shows that all experimental groups showed a significant pre-posttest improvement in the amount of time they perservered at problems. However, there were no significant between-condition posttest differences on this measure. Treatments, therefore, affected persistence uniformly.

Self-Efficacy

Pretest scores were compared to posttest scores collected prior to the skill test to determine the effect of treatment. As shown in Table 2, the conditions showing a significant improvement were combined verbalization and no verbalization. The changes for strategy verbalization and free verbalization children were at borderline levels of significance. Analysis of variance of these posttest scores revealed a significant treatment effect, $F(3, 40) = 3.42$, $p < .05$. Combined verbalization children exhibited a significantly higher level of self-efficacy ($p < .05$) than did children in each of the other three treatment groups, which did not differ from one another.

Posttest perceived efficacy scores collected before and after the skill test were also compared to determine whether test performance affected self-efficacy. In this comparison, children in both the strategy verbalization and free verbalization conditions increased their perceived efficacy.

Correlational Analyses

Correlational analyses were conducted to gain further information on the relationship between theoretically relevant variables. Two significant correlations were found among the posttest variables. Children's percepts of self-efficacy measured before the skill test were significantly related to subsequent skillful performance, $r(42) = .33$, $p < .05$. Persistence was also significantly related to accurate problem solving, $r(42) = .75$, $p < .01$.

Interest

Table 2 reveals that only combined verbalization children showed a significant increase in arithmetic interest from pre- to posttest. The between-condition posttest comparison for this measure was highly significant, $F(3, 40) = 5.96$, $p < .002$. Individual group comparisons showed that combined verbalization children exhibited significantly greater interest than each of the other treatment conditions ($p < .01$).

As suggested by previous research (Bandura & Schunk, in press), perceived efficacy may relate to interest in at least two ways. A moderate degree of efficacy may be necessary for interest to develop, but further increases in efficacy do not give rise to increasingly higher interest. To test this threshold hypothesis, posttest efficacy scores collected after the skill test were correlated with interest scores. Efficacy was represented as a categorical variable with scores in the upper half of the scale defined as efficacious and those in the lower half defined as inefficacious. Correlations were computed separately within each experimental condition and were averaged using an r to z transformation since there was no significant between-condition difference (Edwards, 1976).

This hypothesis was supported, $r(42) = .45$, $p < .01$. Regardless of treatment, therefore, the higher that level of self-efficacy was following the posttest, the more interest that was subsequently exhibited.

Alternately, perceived efficacy and interest may be related in a linear fashion; that is, the higher the efficacy, the more interest shown. To test this linear hypothesis, children's posttest efficacy scores collected after the skill test were again correlated with interest scores, but for this analysis, efficacy was represented as a continuous variable and was computed by summing children's actual efficacy judgments and dividing by the total number of problems.

For this analysis, a significant between-condition difference was found. Mean strength of self-efficacy was positively related to subsequent interest for combined

verbalization children, $r(9) = .86$, $p < .01$, and for no verbalization subjects, $r(9) = .72$, $p < .02$, but not in the other two treatments.

Discussion

The present experiment clarifies the role of verbalization in the development of cognitive skills. Combining solution strategies with free verbalization fostered development of skills, persistence, and percepts of efficacy. In contrast, the other treatments had variable effects. Although equally effective in promoting persistence, none of the other treatments was as effective in promoting percepts of efficacy, and only free verbalization instilled skill equally well.

The superiority of the combined verbalization treatment may be explained as follows. Verbalizing specific strategies has attentional effects (Levin et al., 1975). Attentional focus on problem-solving strategies increases understanding of task demands, which is necessary for the development of veridical self-efficacy (Bandura, 1981). When strategies are supplemented with self-generated verbalizations that tie strategies to specific problems, subjects are likely to perceive the progress they are making. Clear evidence of progress enhances self-percepts of efficacy, (Bandura, 1981).

Free verbalization alone was effective in promoting skill but did not enhance efficacy as did combined verbalization. Lacking the benefit of strategy descriptors, the children in this condition had to infer the solution steps from the exemplar provided. Because they received no feedback indicating whether their inferences were correct, free verbalization children may have been less sure that what they were doing was correct. Such uncertainties would retard self-efficacy development. However, the inferential activity that they engaged in promoted their skills.

Surprisingly, verbalizing strategies alone was no more effective than was merely providing training. This result is consistent with findings reported by

Denney (1975) that repetition of problem-solving strategies produced no benefit over and above observations of models. As suggested by Ghatala et al. (in press), it is possible that such structured responding results in rote-like cognitive processing. Despite the attentional benefits, such rote activity might not facilitate comprehension of how to apply the strategies. This would be especially true for tasks requiring integrative activity, such as those of the present study. Since no verbalization children had access to the same information as strategy verbalization children, they had an adequate basis for developing skills.

This research provides support for the idea that the development of interest is in part a function of percepts of self-efficacy and also clarifies this relationship. Regardless of treatment condition, children who judged their arithmetic efficacy at moderate to high levels later showed more interest in solving such problems. This finding is consistent with previous research (Bandura & Schunk, in press), and supports the idea that the development of interest is in part dependent on increases in perceived efficacy. However, it was primarily children in the combined verbalization condition who showed the most interest. Compared with the other treatments, these children gained the strongest percepts of self-efficacy as a result of treatment.

The procedures employed in the combined verbalization treatment seem well-suited to promote interest. Because they convey the nature of the task demands and promote application of strategies to problems, they also highlight the perception of developing mastery. As one's sense of mastery improves, one should be more likely to engage in the task when not required to do so. These considerations suggest that other treatments would promote interest provided they accurately convey task demands and promote the perception of progress. Research is needed on the effectiveness of other treatments in fulfilling these functions.

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Table 1

Pre- and Posttest Means and Standard Deviations

Meaure	Phase	Strategy Verbalization		Free Verbalization		Combined Verbalization		No Verbalization	
		M	SD	M	SD	M	SD	M	SD
Skill[a]	Pretest	1.3	1.5	1.8	1.7	1.8	1.4	1.6	2.0
	Posttest	5.7	3.8	10.5	3.6	10.9	2.0	6.9	3.5
Persistence[b]	Pretest	34.1	18.7	38.8	28.8	40.7	25.1	35.0	16.9
	Posttest	81.5	37.3	114.9	48.5	111.9	29.9	99.4	47.9
Self-Efficacy[c]	Pretest	3.2	3.1	3.8	4.7	2.7	3.0	3.7	3.7
	Posttest_1[d]	5.5	4.2	6.7	4.6	10.7	2.5	6.0	5.3
	Posttest_2[e]	8.5	3.6	10.6	3.6	11.8	3.1	7.6	6.0
Interest[f]	Pretest	5.1	5.0	3.5	4.1	3.9	6.0	3.6	3.3
	Posttest	4.0	5.1	5.0	5.7	12.8	7.0	4.7	4.3

Note. $N = 44$; $n = 11$.

[a]Number of accurate solutions on 14 problems.

[b]Average number of seconds per problem.

[c]Number of efficacious judgments on 14 problems.

[d]Measured before the skill test.

[e]Measured after the skill test.

[f]Number of division problems completed during interest test.

Table 2

Significance of Intragroup Changes (t values)

Measure	Strategy Verbalization	Free Verbalization	Combined Verbalization	No Verbalization
Skill	4.25***	8.69****	12.22****	5.32****
Persistence	3.58***	4.29***	6.73****	4.13***
Self-Efficacy				
Pre vs. Post	2.12*	1.97*	6.68****	2.70**
$Post_1$ vs. $Post_2$	3.36***	3.36***	0.90	1.50
Interest	-0.75	0.65	3.00**	0.63

Note. Measures are described in Table 1.

* $p < .10$

** $p < .05$

*** $p < .01$

**** $p < .001$